Claims

What is claimed is:

1. A method for measuring the flow velocity of a fluid flowing through an elongated body substantially along the longest axis of the elongated body, the method comprising:

providing an array of at least two ultrasonic sensor units disposed at predetermined locations along the elongated body, each sensor unit including an ultrasonic transmitter and an ultrasonic receiver, each sensor unit providing a respective signal indicative of a parameter of an ultrasonic signal propagating between each respective ultrasonic transmitter and ultrasonic receiver;

processing the transit time signals to define a convective ridge in the k-ω plane; and

determining the slope of at least a portion of the convective ridge to determine the flow velocity of the fluid.

2. The method of claim 1, wherein the processing the transit time signals comprises:

sampling the transit time signals over a predetermined time period;

accumulating the sampled transit time signals over a predetermined sampling period; and

processing the sampled transit time signals to define the convective ridge in the k-ω plane.

3. The method of claim 1, further comprising:

determining the orientation of the convective ridge in the k-ω plane.

4. The method of claim 1, wherein the transit time signals are indicative of vortical disturbances within the fluid.

5. The method of claim 1, wherein the processing the transit time signals comprises:

performing a beam forming algorithm.

6. The method of claim 5, wherein the beam forming algorithm includes one of a Capon Algorithm and MUSIC Algorithm.

7. The method of claim 1, wherein the determining the slope of at least a portion of the convective ridge comprises:

approximating the convective ridge as a straight line.

8. The method of claim 1, wherein the providing an array of at least two ultrasonic sensor units comprises:

disposing the ultrasonic transmitter and ultrasonic receiver of a sensor unit such that the ultrasonic signal propagating therebetween is orthogonal to the direction of the fluid flow.

9. The method of claim 1, further including:

determining the cross-sectional area of the elongated body; and

determining the volumetric flow rate of the fluid.

10. The method of claim 1, wherein the parameter of the ultrasonic signal is at least one of the amplitude and the transit time.

11. An apparatus for measuring the flow velocity of a fluid flowing through an elongated body substantially along the longest axis of the elongated body, the apparatus comprising:

an array of at least two ultrasonic sensor units disposed at predetermined locations along the elongated body, each sensor unit including an ultrasonic transmitter and an ultrasonic receiver, each sensor unit providing a respective signal indicative of a parameter of an ultrasonic signal propagating between each respective ultrasonic transmitter and ultrasonic receiver; and

a processor that defines a convective ridge in the k-ω plane in response to the ultrasonic signals, and determines the slope of at least a portion of the convective ridge to determine the flow velocity of the fluid.

12. The apparatus of claim 11, wherein the processor samples the ultrasonic signals over a predetermined time period, accumulates the sampled ultrasonic signals over a predetermined sampling period, and processes the sampled ultrasonic signals to define the convective ridge in the k-ω plane.

13. The apparatus of claim 11, wherein the processor further determines the orientation of the convective ridge in the k-ω plane.

14. The apparatus of claim 11, wherein the ultrasonic signals are indicative of vortical disturbances with the fluid.

15. The apparatus of claim 11, wherein the processor uses a beam forming algorithm to define the convective ridge in the k-ω plane.

16. The method of claim 15, wherein the beam forming algorithm includes one of a Capon Algorithm and a MUSIC Algorithm.

17. The apparatus of claim 11, wherein the processor determines the slope of at least a portion of the convective ridge by approximating the convective ridge as a straight line.

18. The apparatus of claim 11, wherein the ultrasonic transmitter and ultrasonic receiver of a sensor unit are disposed such that the ultrasonic signal propagating therebetween is orthogonal to the direction of the fluid flow.

19. The apparatus of claim 11, wherein the processor further determines the cross-sectional area of the elongated body, and determines the volumetric flow rate of the fluid.

20. The apparatus of claim 11, wherein the parameter of the ultrasonic signal is at least one of the amplitude and the transit time.

21. An apparatus for measuring the flow velocity of a fluid flowing through an elongated body substantially along the longest axis of the elongated body, the apparatus comprising:

an array of at least two ultrasonic sensor units disposed at predetermined locations along the elongated body, each sensor unit including an ultrasonic transmitter and an ultrasonic receiver, each sensor unit providing a respective signal indicative of a parameter of an ultrasonic signal propagating between each respective ultrasonic transmitter and ultrasonic receiver;

means for processing the ultrasonic signals to define a convective ridge in the k-ω plane; and

means for determining the slope of at least a portion of the convective ridge to determine the flow velocity of the fluid.